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71477 U.S. PTO  
04/23/97

**Box Patent Application**  
Assistant Commissioner of Patents  
Washington, D.C. 20231

**PATENT**  
Atty. Docket No. AUR-002  
(5441/3)

68588 U.S. PTO  
08/841502  
04/23/97

### NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of  
Inventor(s): Vincent Palermo, Patrick J. Cobler, and Neal R. Butler

**WARNING:** Patent must be applied for in the name(s) of all of the actual inventor(s). 37 CFR 1.41(a) and 1.53(b)

For (title): TIME-MULTIPLEXED SHORT-RANGE MAGNETIC  
COMMUNICATIONS

#### 1. Type of Application

This new application is for a(n) (check one applicable item below):

- ☒ Original  
☐ Design  
☐ Plant

**WARNING:** Do not use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. 371(c)(4) unless the International Application is being filed as a divisional, continuation or continuation-in-part application.

**NOTE:** If one of the following 3 items apply then complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED.

- ☐ Divisional  
☐ Continuation  
☒ Continuation-in-Part

#### CERTIFICATE OF EXPRESS MAILING UNDER 37 C.F.R. 1.10

I hereby certify that the attached document is being deposited with the United States Postal Service, postage prepaid, on April 23, 1997 utilizing the "Express Mail Post Office to Addressee" service of the United States Postal Service, mailing label number TB725397805US, in an envelope addressed to the Assistant Commissioner for Patents, Washington, DC 20231.

*Marianne Wettonis*  
Marianne Wettonis

2. Benefit of Prior U.S. Application(s) (35 USC 120)

NOTE: If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., then check either the first option below or the second option below. If the second option is checked, the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION (S) IS CLAIMED must be completed and attached.

- ☒ The new application transmitted claims the benefit of prior U.S. application(s) and the priority information is contained in the enclosed new application
- ☐ The new application being transmitted claims the benefit of prior U.S. application(s) and enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

3. Papers Enclosed Which Are Required For Filing Date Under  
37 CFR 1.53(b) (Regular) or 37 CFR 1.153 (Design) Application

13 Pages of specification  
2 Pages of claims  
1 Pages of Abstract  
4 Sheets of drawing

- ☐ formal
- ☒ informal

**WARNING:** DO NOT submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. **Only one copy is required or desired.** Comments on proposed new 37 CFR 1.84. Notice of March 9, 1988 (1990 O.G. 57-62).

NOTE: "Identifying indicia such as the serial number, group and unit, title of the invention, attorney's docket number, inventor's name, number of sheets, etc., not to exceed 2-3/4 inches (7.0 cm.) in width may be placed in a centered location between the side edges within three fourths inch (19.1 mm.) of the top edge. Either this marking technique on the front of the drawing or the placement, although not preferred, of this information and the title of the invention on the back of the drawings is acceptable." Proposed 37 CFR 1.84(1). Notice of March 9, 1988 (1090 O.G. 67-62).

4. Additional papers enclosed

- ☐ Preliminary Amendment
- ☐ Information Disclosure Statement
- ☐ Form PTO-1449
- ☐ Citations
- ☐ Declaration of Biological Deposit

- ☐ Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.
- ☐ Authorization of Attorney(s) to Accept and Follow Instructions from Representative
- ☐ Special Comments
- ☐ Other

**5. Declaration or oath**

- ☐ Enclosed but unexecuted.
- ☒ Enclosed  
executed by (check all applicable boxes)
  - ☒ inventor(s).
  - ☐ legal representative of inventor(s). 37 CFR 1.42 or 1.43
  - ☐ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.
    - ☐ this is the petition required by 37 CFR 1.47 and the statement required by 37 CFR 1.47 is also attached.  
See item 13 below for fee.
- ☐ Not Enclosed.

**WARNING:**

Where the filing is a completion in the U.S. of an International Application but where a declaration is not available or where the completion of the U.S. application contains subject matter in addition to the International Application the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.

- ☐ Application is made by a person authorized under 37 CFR 1.41(c) on behalf of all the above named inventor(s). The declaration or oath, along with the surcharge required by 37 CFR 1.16(e) can be filed subsequently.

**NOTE:** It is important that **all** the correct inventor(s) are named for filing under 37 CFR 1.41(c) and 1.53(b).

- ☐ Showing that the filing is authorized.  
(Not required unless called into question. 37 CFR 1.41(d).)

**6. Inventorship Statement**

**WARNING:** If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.

The inventorship for all the claims in this application are:

- ☐ The same
- ☐ Are not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,
- ☐ is submitted.
- ☐ will be submitted.

## 7. Language

NOTE: An application including a signed oath or declaration may be filed in a language other than English. A verified English translation of the non-English language application and the processing fee of \$130.00 required by 37 CFR 1.17(k) is required to be filed with the application or within such time as may be set by the Office. 37 CFR 1.52(d).

NOTE: A non-English oath or declaration in the form provided or approved by the PTO need not be translated. 37 CFR 1.69(b).

- ☐ English
- ☐ non-English
- ☐ the attached translation is a verified translation. 37 CFR 1.52(d).

## 8. Assignment

- ☒ An assignment of the invention to Aura Communications, Inc.
- ☒ is (are) attached. A separate "ASSIGNMENT COVER LETTER ACCOMPANYING NEW PATENT APPLICATION" is also attached.
- ☐ will follow.

NOTE: "If an assignment is submitted with a new application, send two separate letters -- one for the application and one for the assignment." Notice of May 4, 1990 (1114 D.G. 77-78).

**9. Certified Copy**

Certified copy(ies) of the application(s)

[illegible]

from which priority is claimed

☐ is (are) attached.

☐ will follow.

NOTE: The foreign application forming the basis for the claim for priority **must** be referred to in the **oath** or **declaration**. 37 CFR 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. 120 is itself entitled to priority from a prior foreign application then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

**10. Fee Calculation (37 CFR 1.16)**

A. ☒ **Regular application**

**CLAIMS AS FILED**

	<b>Number Filed</b>	<b>Number Extra</b>		<b>Rate</b>	<b>Basic Fee 37 CFR 1.16(a) \$770.00</b>
Total Claims (37 CFR 1.16 (c))	7	- 20 = 0	X	\$ 22.00	\$
Independent Claims (37 CFR 1.16 (b))	2	- 3 = 0	X	\$ 80.00	\$
Multiple Dependent Claim(s), If any (37 CFR 1.16(d))			+	\$ 260.00	\$

☐ Amendment canceling extra claims enclosed.

☐ Amendment deleting multiple-dependencies enclosed.

☐ Fee for extra claims is not being paid at this time.

NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims canceled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 CFR 1.16(d).

Filing Fee Calculation \$ 770.00

B. ☐ **Design application**  
(\$320.00--37 CFR 1.16(f))

Filing Fee Calculation \$

C. ☐ **Plant application**  
(\$530.00--37 CFR 1.16(g))

Filing Fee Calculation \$

456789 2034567

11. Small Entity Statement(s)

- ☒ Verified Statement(s) that this is a filing by a small entity under 37 CFR 1.9 and 1.27 is (are) attached.

Filing Fee Calculation (50% of A, B or C above) \$ 385.00

NOTE: Any excess of the full fee paid will be refunded if a verified statement and a refund request are filed within 2 months of the date of timely payment of a full fee. 37 CFR 1.28(a).

12. Request for International-Type Search (37 CFR 1.104(d)) (complete, if applicable)

- ☐ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

13. Fee Payment Being Made At This Time

- ☐ Not Enclosed
- ☐ No filing fee is to be paid at this time. (This and the surcharge required by 37 CFR 1.16(e) can be paid subsequently.)
- ☒ Enclosed
- |   |                  |
|---|------------------|
| <input checked="" type="checkbox"/> basic filing fee  | \$ <u>385.00</u> |
| <input checked="" type="checkbox"/> recording assignment<br>(\$40.00; 37 CFR 1.21(h))   | \$ <u>40.00</u>  |
| <input type="checkbox"/> petition fee for filing by other than all the<br>inventors or person on behalf of the<br>inventor where inventor refused to sign<br>or cannot be reached.<br>(\$130.00; 37 CFR 1.47 and 1.17(h)) | \$               |
| <input type="checkbox"/> for processing an application with a<br>specification in a non-English language.<br>(\$130.00; 37 CFR 1.52(d) and 1.17(k))   | \$               |
| <input type="checkbox"/> processing and retention fee (\$130.00;<br>37 CFR 1.53(d) and 1.21 (1).  | \$               |
| <input type="checkbox"/> fee for international-type search report<br>(\$40.00; 37 CFR 1.21 (e)).  | \$               |

NOTE: 37 CFR 1.21(l) establishes a fee for processing and retaining any application which is abandoned for failing to complete the application pursuant to 37 CFR 1.53(d) and this, as well as the changes to 37 CFR 1.53 and 1.78, indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing

0344304420

fee must be paid or the processing and retention fee of § 1.21(l) must be paid within 1 year from notification under § 53(d).

Total fees enclosed \$ 425.00

14. Method of Payment of Fees

- ☒ Checks in the amounts of \$385.00 and \$40.00
- ☐ Charge Account No.20-0531 in the amount of \$ \_\_\_\_\_. A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 CFR 1.22(b).

15. Authorization to Charge Additional Fees

WARNING: If no fees are to be paid on filing the following items should not be completed.

WARNING: Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.

- ☒ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. 20-0531.

- ☒ 37 CFR 1.16(a),(f) or (g) (filing fees)
- ☒ 37 CFR 1.16(b),(c) and (d)(presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims canceled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 CFR 1.16(d), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

- ☐ 37 CFR 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)
- ☐ 37 CFR 1.17 (application processing fees)

WARNING: While 37 CFR 1.17(a),(b), (c) and (d) deal with extensions of time under § 1.136(a) this authorization should be made only with the knowledge that: "Submission of the appropriate extension fee under 37 C.F.R. 1.136(a) is to no avail unless a request or petition for extension is filed." (Emphasis added). Notice of November 5, 1985 (1060 O.G. 27).

- ☐ 37 CFR 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 CFR 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance, 37 CFR 1.31(b).


NOTE: 37 CFR 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . issue fee". From the

0004460 04239 456340 2005T4230

## 16. Instructions As To Overpayment

☐ refund

295RJT5441/3.351698-1

  
Robert J. Tosti  
Attorney for Applicant(s)  
Testa, Hurwitz, & Thibeault, LLP  
High Street Tower  
125 High Street  
Boston, Massachusetts 02110



## PATENT

Atty. Docket No. AUR-002  
(5441/3)

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Palermo et al.

Serial No.: Not yet assigned

Filed: Herewith

For: TIME-MULTIPLEXED SHORT-RANGE MAGNETIC COMMUNICATIONS

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY  
STATUS (37 CFR 1.9(f) AND 1.27(c)) - SMALL BUSINESS CONCERN

I hereby declare that I am

- ☐ the owner of the small business concern identified below;
- ☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: Aura Communications, Inc.ADDRESS OF CONCERN: 187 Ballardvale Road, Wilmington, MA 01887

I hereby declare that the above identified small business qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third-party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed, to and remain with the small business concern identified above with regard to the invention, entitled.

TIME-MULTIPLEXED SHORT-RANGE MAGNETIC COMMUNICATIONS

by inventor(s) Vincent Palermo, Patrick J. Cobler, and Neal R. Butler  
described in

- ☒ the specification filed herewith.
- ☐ application serial no. 0\_\_\_\_/\_\_\_\_ filed \_\_\_\_.
- ☐ patent no. \_\_\_\_\_, issued \_\_\_\_\_.

Verified Statement (Declaration) Claiming Small Entity Status (37 CFR 1.9(f) and 1.27 (c)) - Small Business Concern

Page 2

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below\* and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9(d) or by any concern which would not qualify as a small business concern 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

\*NOTE: Separate verified statements are required for each named person, concern or organization having rights to the invention averring to their status as small entities (37 CFR 1.27).

NAME -----

ADDRESS -----

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

NAME -----

ADDRESS -----

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small business entity is no longer appropriate. (37 CFR 1.28(b)).

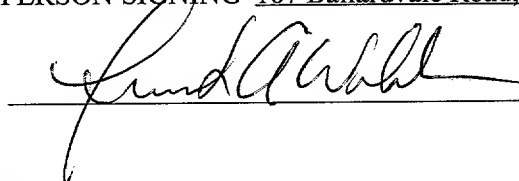
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING Frank A. Waldman

TITLE OF PERSON OTHER THAN OWNER President

ADDRESS OF PERSON SIGNING 187 Ballardvale Road, Wilmington, MA 01887

SIGNATURE



Date

4/4/97

EXPRESS MAIL MAILING LABEL

No. TB 725 397 80545

UTILITY PATENT APPLICATION

Attorney Docket No. AUR-002 (5441/3)



TO ALL WHOM IT MAY CONCERN:

Be it known that we,

(1) Vincent Palermo, a citizen of the U.S.A. residing at 13 Stony Brook Road,  
Westford, MA 01886,

(2) Patrick J. Cobler, a citizen of the U.S.A. residing at 105 Concord Avenue,  
Belmont, MA 02178, and

(3) Neal R. Butler, a citizen of the U.S.A. residing at 144 School Street, Acton,  
MA 01720,

have invented

**TIME-MULTIPLEXED SHORT-RANGE MAGNETIC COMMUNICATIONS**

of which the following is a specification.

## TIME-MULTIPLEXED SHORT-RANGE MAGNETIC COMMUNICATIONS

### Cross-Reference to Related Applications

This is a continuation-in-part of: (1) U.S. patent application serial number 08/444,017, filed May 18, 1995; and (2) U.S. patent application serial number 08/696,812, filed August 13, 1996. The entirety of each of these two related U.S. patent applications is hereby incorporated hereinto by reference.

### Technical Field

This invention relates to short-range wireless communications and, more particularly, to the use of inductive coupling.

### Background Information

When using a telephone, continually holding the handset to one's ear can be awkward. Also, holding the telephone interferes with the use of both hands for other work while trying to talk. In particular, the use of cellular telephones, which has increased dramatically, can interfere with the user's proper operation of an automobile. Various techniques have been used to overcome these difficulties.

Speakerphones allow one to talk while roaming around a room and using one's hands. However, speaker volume can disturb others around the user. They also cannot be used in close proximity to other speakerphones due to interference. They have limited privacy since the speaker broadcasts the conversation to all within earshot. Typically, the user must speak more loudly than normal to have proper reception at the microphone. Also, they tend to have poor

sound quality because the user typically is not near the microphone and acoustics in the room typically are poor.

Headsets have been another way to free up the hands of a telephone user. Typically, the headset includes an adjustable strap extending across the user's head to hold the headset in place, at least one headphone located by the user's ear, and a microphone which extends from the headset along and around the user's face to be positioned in front of the users mouth. The headset is attached by a wire to the telephone. Headsets have the disadvantages of being bulky and somewhat awkward to use. Although they permit hands free use of the telephone, the user has limited mobility due to the connecting wire.

Wireless headsets also have been developed to eliminate the connecting wire to the telephone. The wireless headset uses radio frequency (RF) technology or infrared (IR) technology for communicating between the headset and a base unit coupled to the telephone. The need for communications circuitry and sufficient power to communicate with the base unit increases the bulk and weight of the headset. This increased weight can become tiresome for the user. One alternative has been to attach the headset by a wire to a transmitting unit worn on the belt of the user. Again, the use of a connecting wire can become inconvenient and interfere with other actions by the user. Significant interference rejection circuitry is also needed when multiple wireless headsets are used in close proximity.

### Summary of the Invention

The invention relates to a short-range, wireless communications system including a miniaturized portable transceiver unit and a base unit transceiver. The miniaturized portable transceiver unit sends and receives information through magnetic induction to the base unit, which may also be portable (i.e., easily carried by hand by a single person). Similarly, the base unit sends and receives information through magnetic induction to the portable transceiver. The information generally can be any type of information including voice, audio, data, music, and/or video. The use of magnetic induction fields limits interference between a plurality of systems operating in close proximity to each other, and it reduces the power requirements (e.g., the battery or batteries in the two units can be smaller in size and weight) which allows smaller size units and greater convenience as compared to other types of communications systems such as those using RF technology and IR technology.

Each of the base unit and the portable transceiver units includes one or more transducers. Each of the transducers preferably is a rod antenna such as a ferrite rod within a wire coil. Either or both of the units can include multiple transducers arranged in a variety of configurations to generate multiple magnetic fields, and in such multiple-transducer embodiments a diversity circuit is used to receive and/or transmit on at least one of the transducers. For example, three orthogonally arranged transducers can be used in the base unit, the portable unit, or both. For each unit, whatever the physical arrangement of that unit's transducers with respect to each other, the multiple fields generated substantially eliminates mutual inductance nulls between the two units which typically occurs at certain positions in a generated magnetic field. In one embodiment, the multiple transducers are selectively operated based upon a strongest signal in order to limit power consumption.

In one embodiment according to the invention, the system is a time-multiplexed short-range wireless communications system including a headset with the miniaturized transceiver that communicates with the base unit through magnetic induction fields. The headset may be of the concha type in which the speaker fits into at least one of the user's ears without a strap across the head and the transceiving transducer is encapsulated into the microphone boom which is short and straight along the user's cheek. Also, the base unit may be a portable telephone, which can

be attached to the user, to further transmit communications from the wireless communication system to a separate device such as a cellular telephone network or a cordless telephone unit. The headset may fit in a receptacle in the portable base unit in order to recharge the battery pack in the headset, and the battery pack may be recharged via the magnetic inductive link between the base unit and the headset.

In one aspect, the invention relates to a magnetic induction time-multiplexed two-way short-range wireless communications system. The system includes a first portable unit and a second portable unit. The first portable unit receives first unit input signals and provides first unit output signals, and the first portable unit includes a first unit transducer system for generating a first inductive field based upon the first unit input signals during a first time slot and for converting a second inductive field into the first unit output signals during a second time slot. The second portable unit receives second unit input signals and provides second unit output signals, and the second portable unit includes a second unit transducer system for generating the second inductive field based upon the second unit input signals during the second time slot and for converting the first inductive field into the second unit output signals during the first time slot.

In another aspect, the invention involves a method for magnetic induction time-multiplexed two-way short-range wireless communications. During a first predetermined period of time, a first portable unit with a first unit transducer system generates a first inductive field and a second portable unit with a second unit transducer system receives the first inductive field. During a second predetermined period of time, the second portable unit with the second unit transducer system generates a second inductive field and the first portable unit with the first unit transducer system receives the second inductive field.

The foregoing and other objects, aspects, features, and advantages of the invention will become more apparent from the following description and from the claims.

### Brief Description of the Drawings

In the drawings, like reference characters generally refer to the same parts throughout the different views. Also, the drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention.

FIG. 1 is a schematic illustration of a wireless communication system according to the invention.

FIG. 2 is an illustration of a telephone handset as a base unit in the communication system of FIG. 1.

FIG. 3 is an illustration of a headset utilized as a portable device in the communication system of FIG. 1.

FIG. 4 is a schematic illustration of a transducer and electronics of a portable device according to the invention.

FIG. 5 is a schematic illustration of a transducer and electronics of a base unit according to the invention.

FIG. 6 is an illustration of another transducer configuration for the base unit.

FIG. 7A is a block diagram of a time-multiplexed short-range wireless communications system according to the invention.

FIG. 7B is a more detailed diagram of the system of FIG. 7A.



### Description

Referring to FIG. 1, a short-range magnetic communication system 1 includes a portable device 2 and a base unit 1 which connects to a long-range communication network 14. Contained within each of the base unit 1 and the portable device 2 is a short-range miniaturized magnetic induction transceiver 11, 12 which can simultaneously transmit and receive communications signals 13. These signals may be voice, audio, data, or video. The communications network 14 may be any network in which it would be desirable for these signals to be communicated over a terminal link without wires, such as a telephone network, personal communications (PCS) network, special mobile radio (SMR) network, computer system or network, and video conferencing systems. The base unit 1 may any part of the communications network 14 from which it would be desirable to communicate to another device without wires; for example, it may be a telephone handset, PCS handset, SMR handset, walkie-talkie, computer or computer peripheral devices, Personal digital assistant (PDA), or video game controller. The portable device 2 may be any device from which it would be desirable to communicate without wires to a communications network; for example, it may be a telephone headset or handset, portable computer or computer peripheral device, headphone, or video input device.

Referring to FIG. 2, one example of the base unit 1 is a portable telephone 10 having a plurality of number buttons 15 and a plurality of function buttons 16. A retractable antenna 17 communicates with a cellular telephone network or a cordless telephone base unit. The portable telephone 10 operates in a manner similar to that of an ordinary cellular or cordless telephone handset. Signals are sent to and received from the telephone network in an ordinary manner. The portable telephone 10 includes a transducer system 30 which communicates by magnetic induction with headset 20, which operates as the portable device 2, to provide the outputs and inputs to the portable telephone 10. The portable telephone 10 may also include a mouthpiece or earpiece (not shown) as in a regular telephone handset, allowing the user to choose between a conventional method of operation and a hands-free use afforded by the headset 20.

The portable device 2 as a headset 20 is shown more fully in FIG. 3. It includes a body portion 23 which houses a transducer 40 and processing circuitry. A speaker 22 is connected to the circuitry within the body 23. An earpiece 21 next to the speaker 22 fits in the user's ear to

hold the unit in place and to allow the user to hear sounds from the speaker. A microphone boom 24 extends from the body 23 several inches in order to place a microphone 25, located at the end of the boom 24, close to the user's mouth. Alternatively the transducer 40 may be housed in the boom 24. A rechargeable battery 51 is also housed in the body 23 of the headset 20 to provide power to the headset. Other features may be optionally included in the headset 20, such as switcher or buttons for manually activating different modes. For example, a capacitive switch or push-button could be used to cause the headset 20 to transmit a control signal to the portable phone 10 to activate muting of the microphone. The portable phone 10 may include a receptacle 19 for receiving and holding the headset 20. Depositing the headset in the receptacle can provide a variety of functions, in addition to maintaining the headset 20 and portable phone 10 together. A switch can be disposed in the receptacle to terminate the telecommunication when the headset 20 is inserted or initiate the telecommunication when it is removed. The receptacle may also include connections to recharge the battery 51 in the headset 20.

The base unit 1 and portable device 2 communicate through amplitude modulation of inductive fields, although other modulation methods such as frequency or phase modulation could be employed. During use, the distance between the portable device 2 and the base unit 1 typically is short. Since the distance is short, only an inductive field is necessary, and little or no radiation occurs. This limits the operating power, which allows a smaller size and weight for the rechargeable battery 51 and, thus, the portable device 2. Furthermore, it limits interference between systems operating in close proximity. Therefore, interference rejection circuitry may be limited or not necessary in the portable device 2.

Referring to FIG. 4, for the transducer system in the portable device 2, the transducer 40 preferably includes a ferrite rod transducer having a ferrite rod 41 within a wire coil 42. The wires from the transducer 40 are connected to a transceiver 27 having transmitter electronics 28 and receiver electronics 29. The transceiver 27 connects to the portable device electronics 26, the nature of which is dependent upon the function of the portable device 2. In the example of the portable device as a headset 20, the portable device electronics would connect to a speaker 22 and a microphone 25. Transmission and reception can occur at different frequencies, which

permits full duplex operation. Alternatively, separate transmitting and receiving transducers can be used.

Referring to FIG. 5, for the base unit 1 configuration, the transducer system 30 includes three orthogonally disposed ferrite rod transducers, each including a ferrite rod 31, 32, 33 and a respective coil 34, 35, 36. The use of the orthogonally disposed transducers overcomes the occurrence of mutual inductance nulls in the resulting inductive fields. The three transducers are connected to multiplexer electronics 60 for selecting one or more of the transducers for transmission and reception. Circuitry may be used to select the transducer or transducers having the strongest signal for transmission and reception to reduce the total power consumption of the device. The transmitter electronics 61 and receiver electronics 62 provide for processing of the communications signals from the base unit electronics 70 and the portable device 2. As discussed above, for a portable telephone 10, the conventional telephone speaker 71 and mouthpiece 72 may be eliminated so that the portable telephone 10 solely uses the headset 20 through the transducer system for communicating to the user. Switching circuitry (not shown) would be included to select between the speaker 71 and microphone 72, and the headset 20. The switching circuitry could be included in the receptacle 19 so that the speaker 71 and microphone 72 are disconnected when the headset 20 is removed.

Referring to FIG. 6, in another embodiment of the transducer system 30 for the base unit 1, one of the ferrite rod transducers is replaced with a loop coil transducer 37. A loop coil transducer can replace any or all of the ferrite rod transducers. The loop coil transducer 37 is disposed in the plane of the remaining ferrite rod transducers. This creates a transducer system having a decreased depth. As shown in FIG. 2, the three orthogonal transducers can be placed in a corner along the sides of the portable telephone 10. Alternatively, the loop coil transducer 37 could be placed along the back of the portable phone 10, so that it could be made thinner.

Additionally, the transmission system can be used for charging the battery 51 of the portable device 2. The base unit 1 includes a battery charger signal generator 52 connected to the transmitter 61. This generator 52 produces a recharging signal which is sent through one of the ferrite rod transducers in the base unit 1 to the ferrite rod transducer 40 of the portable device 2. Since, in the telephone embodiment of FIG. 2, the headset 20 and transducer 40 have a known

orientation when in the receptacle 19, only one transducer in the portable telephone 10 needs to be energized to transmit inductively the recharging signal. As shown in FIG. 3, the wires from the transducer 40 in the portable device 2 are connected to a battery charger 50 which is used to charge the battery 51.

Although the communication system has been illustrated in connection with a concha type headset 20 and a cellular or cordless telephone handset 10 as a base unit 1, it is readily adaptable for other types of headsets and uses. The headset can be of the over-the-head type, over-the-ear type, or binaural type. The system can be used as a wireless connection to a conventional desktop telephone. Such a system would operate in the manner discussed above with the cordless handset. Since several such units may be used in close proximity, interference may become more of a problem. Therefore, the system can be designed to operate on various frequencies and can select frequencies for the transmission and reception which are unlikely to have significant interference. Similarly, the system can be used with a computer, either stationary or portable, for voice data entry, sound transmission, and telephone functions. The system can also be used with other types of communication systems including personal digital assistants (PDAs), cordless phones, PCS and SMR cellular phones, two way (e.g., video games), two-way half duplex (e.g., walkie-talkies and CBs), or two-way full duplex (e.g., phones). When the base unit is stationary and the user is likely to be at certain locations relative to the base unit, fewer transducers may be used in the base unit without encountering mutual inductance nulls. Alternative transducer systems may also be used for generating the inductive fields. Specifically, rather than a single transducer for transmission and reception on different frequencies, separate transducers may be used.

Other embodiments of a communications system according to the invention also are possible. For example, referring back to FIG. 1, the base unit 1 and the portable device 2 can communicate through magnetic induction in both directions using either analog or digital signals and/or transmission techniques. In an embodiment in which the information that is modulated on a carrier and inductively coupled from one unit (e.g., the portable device 2) to the other unit (e.g., the base unit 1) is digital data, the modulation scheme used can involve switching or keying the amplitude, frequency, or phase of the carrier in accordance with the incoming digital data. For

example, the quadrature phase-shift keying (QPSK) modulation scheme can be employed. Other types of modulation schemes can be used such as quadrature-amplitude modulation (QAM). Regardless of whether the information transmitted and received is analog or digital, that information can represent a variety of different types of information such as audio, voice, music, video, data, control signals, etc. In some embodiments, higher carrier frequencies are used to get higher bandwidth communications. For example, a carrier at about 2 MHz can be used.

In a presently preferred embodiment according to the invention, full duplex two-way communication is achieved by time-multiplexing the modulated data in each direction. For speech, a multiplexing rate of 120 Hz can be used, and this corresponds to a delay of 8 milliseconds which is imperceptible to a user/listener.

Referring to FIGS. 7A and 7B, an embodiment of a time-multiplexed short-range wireless magnetic communications system according to the invention includes a portable unit 100 (e.g., the portable device 2) and another portable unit 102 (e.g., the base unit 1). The two portable units 100, 102 generally will be referred to hereinafter as "Side A" and "Side B" for convenience. Side A includes an integrated circuit (IC) 104, an interface 106, and a transducer system 107 (e.g., a single rod antenna). The IC 104 includes a modulator 114 for modulating the digital data, a driver 116 for driving the rod antenna, a demodulator 118 for demodulating the received signal, and a receiver 120 for recovering the small signal from the coil. The interface 106 includes a transmit coil interface circuit 122 for matching the driver to the coil and a receiver coil interface circuit 124 for matching the coil to the receiver. As for Side B, it includes an IC 108, an interface 110, an electronic switch network (ESN) 112, and a transducer system 113 (e.g., three orthogonally-arranged rod antennas - x, y, and z). The IC 108 includes a modulator 126 for modulating the digital data, a driver 128 for driving the rod antenna, a demodulator 130 for demodulating the received signal, a receiver 132 for recording the small signal from the coil, a signal strength indicator 134 for measuring the received signal from each coil, and decision logic 136 for selecting the best coil based on some algorithm. The interface 110 includes a transmit coil interface circuit 138 for matching the driver to the coil and a receiver coil interface circuit 140 for matching the coil to the receiver. The ESN 112 allows the transmit and receive coil interface circuits 138, 140 to be effectively multiplexed between the three rod antennas (x, y,

and z) of the transducer system 113. The ESN 112 thus provides the advantage of reducing the size and cost of the inductive communications system of the invention by eliminating redundant interface components that would otherwise be needed to multiplex between the three rod antennas. That is, without the ESN 112, separate transmit and receive coil interface circuits would be needed for each of the three rod antennas, but with the ESN 112, only a single interface circuit 110 (which includes one transmit coil interface circuit 138 and one receive coil interface circuit 140) is needed in accordance with the invention.

The system of FIGS. 7A and 7B is a two-way system, and the two-way feature is implemented by time-multiplexing information through the inductive link between Side A and Side B. In operation, a typical sequence of events for the time-multiplexed communications system of the invention can be as follows. Side A transmits information (e.g., encoded and time-compressed voice data) to Side B for a prescribed amount of time such as 8 milliseconds using the modulator 114, the driver 116, the interface circuit 122, and the rod antenna 107. Side A starts transmitting by sending synchronization information for a small percentage of its total transmit time slot (e.g., 5 percent of 8 milliseconds or 0.4 milliseconds) referred to as the synchronization period. For the remainder of the transmit time slot (i.e., after the synchronization period but before the expiration of the 8 millisecond transmit time), Side A sends the actual information (e.g., the encoded and time-compressed voice data). Side B uses the synchronization period and timing to synchronize its receiver 132 and select the best coil or rod (x, y, or z) on which to receive the transmission being sent by Side A. The ESN 112, the interface circuit 140, the receiver 132, the signal strength indicator 134, and the decision logic 136 are used by Side B to determine which rod antenna (x, y, or z) is the best for receiving the transmission by Side A. This Side B hardware makes the determination by sequentially scanning each of the three rod antennas once and looking for the best (i.e., strongest) signal. Depending on the relative orientations of the Side A antenna 107 and the Side B transducer system 113, signals of different strengths and polarities will exist on the antennas of Side B (x, y, and z). It is possible that only one (or two) of the three rod antennas could have a signal while the other two (or one) have (or has) no signal. Although the three rod antennas of the transducer system 113 are required for full freedom of movement between Side A and Side B, two rod antennas can be

used instead of three if some preferred orientation is known or desired regarding the two units (i.e., Side A and Side B). Also, a single rod antenna could be used at Side B, although such a single-antenna configuration of Side B's transducer system 113 may make it difficult to communicate when Side A and Side B start moving in an uncontrolled or unanticipated way with respect to each other. At the end of the synchronization period, Side B starts to receive the transmitted information from Side A on the rod antenna (x, y, or z) determined to be best. At the end of the Side A transmit time slot, the two sides (i.e., Side A and Side B) reverse roles, and Side B now transmits while Side A receives.

Side B transmits on the rod antenna it determined to be best for receiving from Side A during the previous time slot in which Side B was receiving from Side A. It should be noted here that, unlike a practical RF communications system, an inductive communications system according to the invention has the characteristic that the transmit and receive paths are substantially reciprocal. That is, the rod antenna that is determined to be the best for reception is also the rod antenna that will be best for transmission. This characteristic is exploited in the invention by transmitting on the rod antenna that was determined to be the best for reception. Side B transmits (on the best rod antenna) synchronization and actual information during the Side B transmit time slot (in the manner described above for Side A when it transmits during the Side A transmit time slot). The Side B transmit time slot can be, for example, 8 milliseconds in length with a beginning synchronization period of 0.4 milliseconds followed by a substantive or actual information transmit period of 7.6 milliseconds. Side A receives the synchronization information and the actual information on its rod antenna 107. Side A uses the synchronization information to synchronize its receiver 120. At the end of the synchronization period, Side A receives the actual information transmitted by Side B during the remainder of the Side B transmit time slot. After the Side B transmit time slot is completed, the process repeats itself. That is, Side A now transmits while Side B receives.

The actual or substantive information that gets sent by Side A is received by Side A on the IN line into the IC 104, and the actual or substantive information that gets sent by Side B is received by Side B on the IN line into the IC 108. Likewise, received and demodulated information is output from Side A and Side B on the OUT line of, respectively, the IC 104 and

the IC 108. In a preferred embodiment, the receiving unit (whether that is Side A or Side B) both receives the transmission from the other unit and collects actual information coming in on its IN line simultaneously. This allows that receiving unit to be prepared to transmit when its turn comes at the end of the current period during which the other unit is transmitting. Similarly, the transmitting unit, while it is transmitting via its transducer system to the now-receiving unit, sends the information it just received in the last time slot out on its OUT line.

Each of the units 100, 102 includes electronic storage or memory (not shown) for storing actual information that is input via the IN line of the unit, and that stored information is extracted and transmitted when it is that unit's turn to transmit. The memory included in each unit 100, 102 typically will hold at least about 16 milliseconds of actual information such as voice data.

An 8 millisecond transmit time slot has been used as an example above for both the Side A and Side B transmit time slots. Transmit time slots of other durations can be used. In general, the duration of the transmit time slot for both Side A and Side B, is selected to allow the transmission and reception of a reasonable amount of information with a minimum of overhead while still maintaining the ability to track movements of the two portable units 100, 102 (i.e., Side A and Side B).

If the system just described communicates digital data, the following might, as an example, be the data stream or data packet that gets sent from one unit to the other:

- 1) a synchronization header having 32 bits followed by
- 2) 12 encryption bits followed by
- 3) voice data represented by 512 bits followed by
- 4) 12 termination bits.

Variations, modifications, and other implementations of what is described herein will occur to those of ordinary skill in the art without departing from the spirit and the scope of the invention as claimed. Accordingly, the invention is to be defined not by the preceding illustrative description but instead by the spirit and scope of the following claims.

What is claimed is:



Claims

1. A magnetic induction time-multiplexed two-way short-range wireless communications system, comprising:

a first portable unit for receiving first unit input signals and for providing first unit output signals, the first portable unit including a first unit transducer system for generating a first inductive field based upon the first unit input signals during a first time slot and for converting a second inductive field into the first unit output signals during a second time slot; and

a second portable unit for receiving second unit input signals and for providing second unit output signals, the second portable unit including a second unit transducer system for generating the second inductive field based upon the second unit input signals during the second time slot and for converting the first inductive field into the second unit output signals during the first time slot.

2. The system of claim 1 wherein the second unit transducer system comprises a single transducer.

3. The system of claim 2 wherein the single transducer comprises a rod antenna.

4. The system of claim 1 wherein the first unit transducer system comprises a plurality of transducers.

5. The system of claim 4 wherein the plurality of transducers comprises an array of rod antennas.

7. A method for magnetic induction time-multiplexed two-way short-range wireless communications, comprising:

during a second predetermined period of time, generating from the second portable unit with the second unit transducer system a second inductive field and receiving the second inductive field at the first portable unit with the first unit transducer system.

## **TIME-MULTIPLEXED SHORT-RANGE MAGNETIC COMMUNICATIONS**

### Abstract of the Disclosure

A magnetic induction time-multiplexed two-way short-range wireless communications system, and related method, includes a first portable unit and a second portable unit. The first portable unit receives first unit input signals and provides first unit output signals. Also, the first portable unit includes a first unit transducer system for generating a first inductive field based upon the first unit input signals during a first time slot and for converting a second inductive field into the first unit output signals during a second time slot. The second portable unit receives second unit input signals and provides second unit output signals. Also, the second portable unit includes a second unit transducer system for generating the second inductive field based upon the second unit input signals during the second time slot and for converting the first inductive field into the second unit output signals during the first time slot.

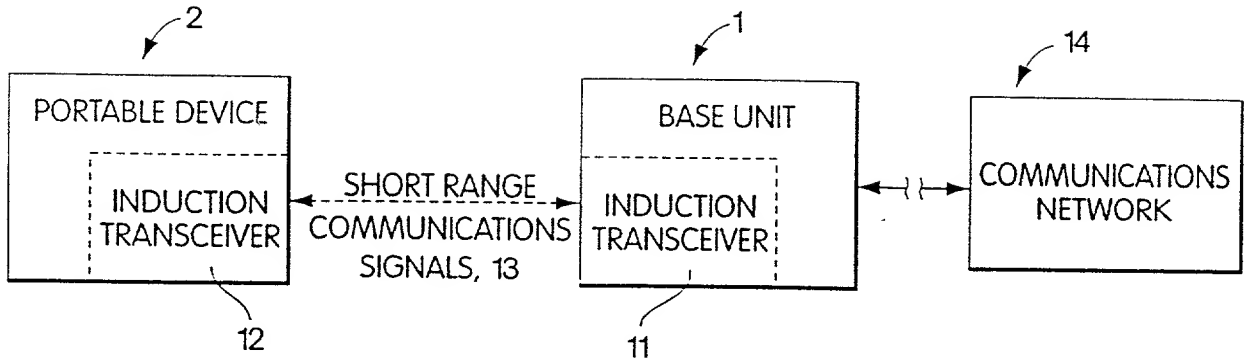


Fig. 1

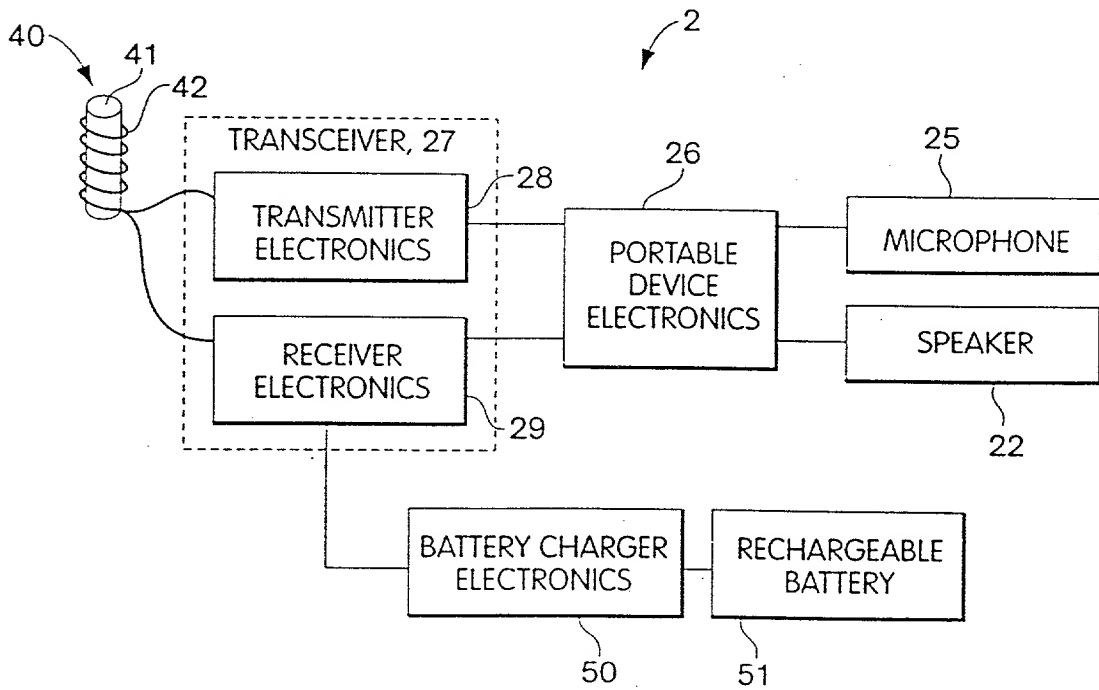


Fig. 4

2004-03-14

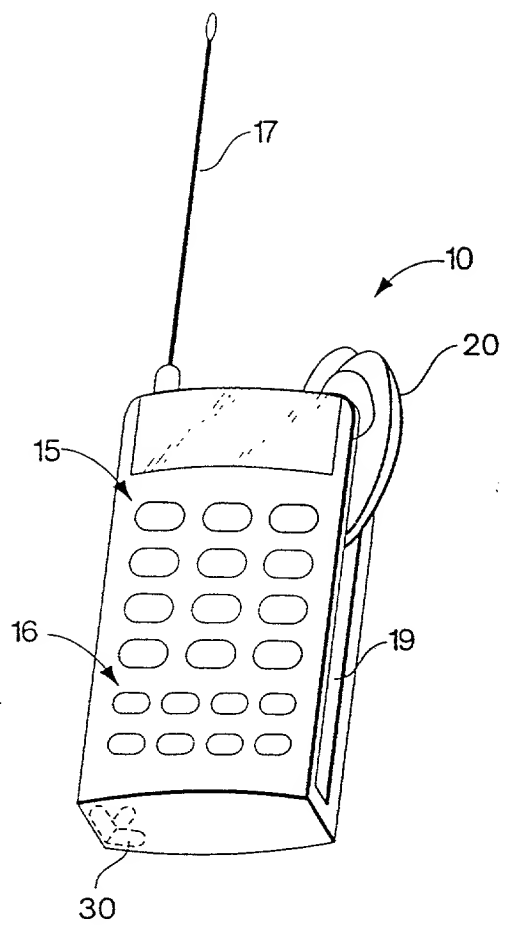


Fig. 2

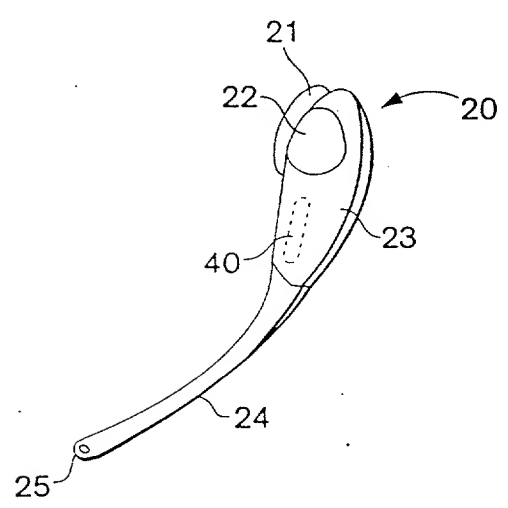


Fig. 3

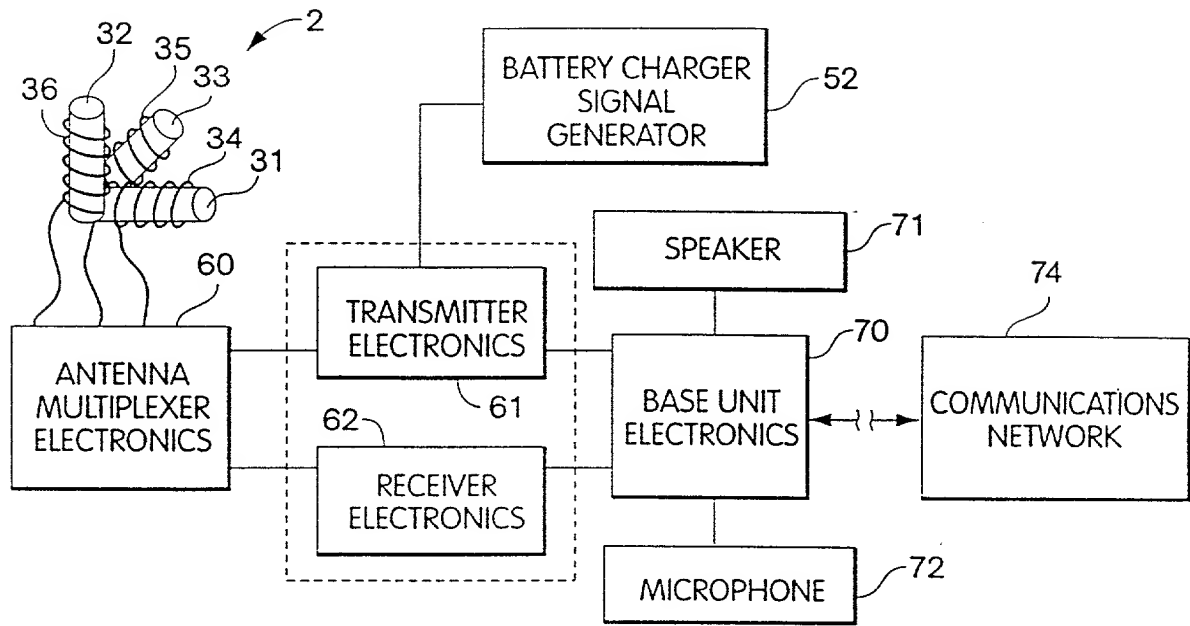


Fig. 5

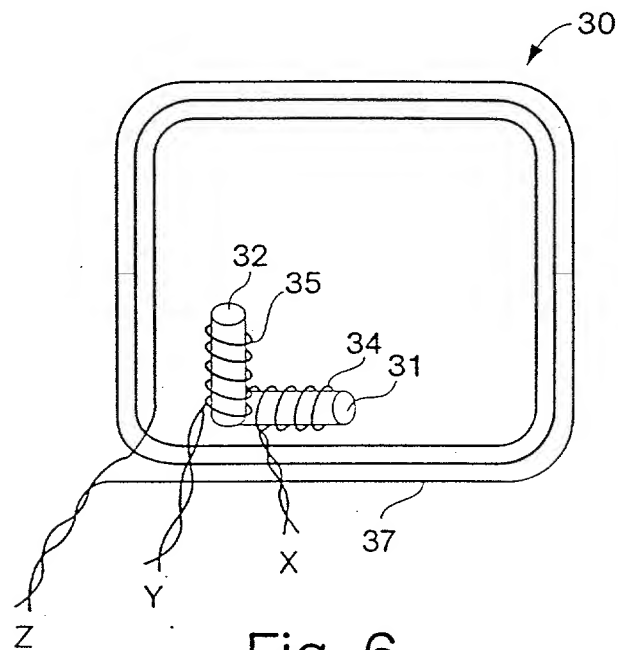
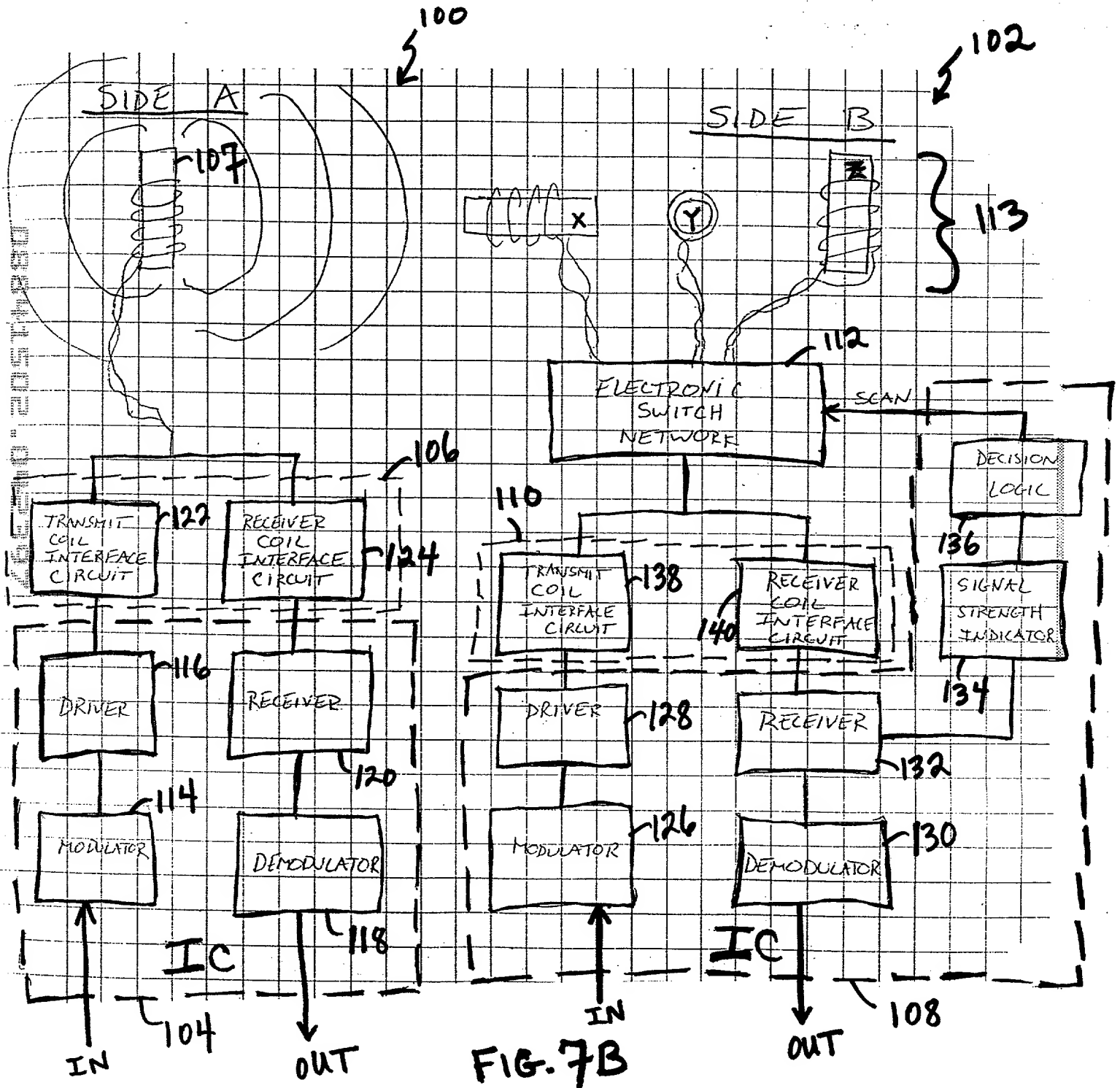
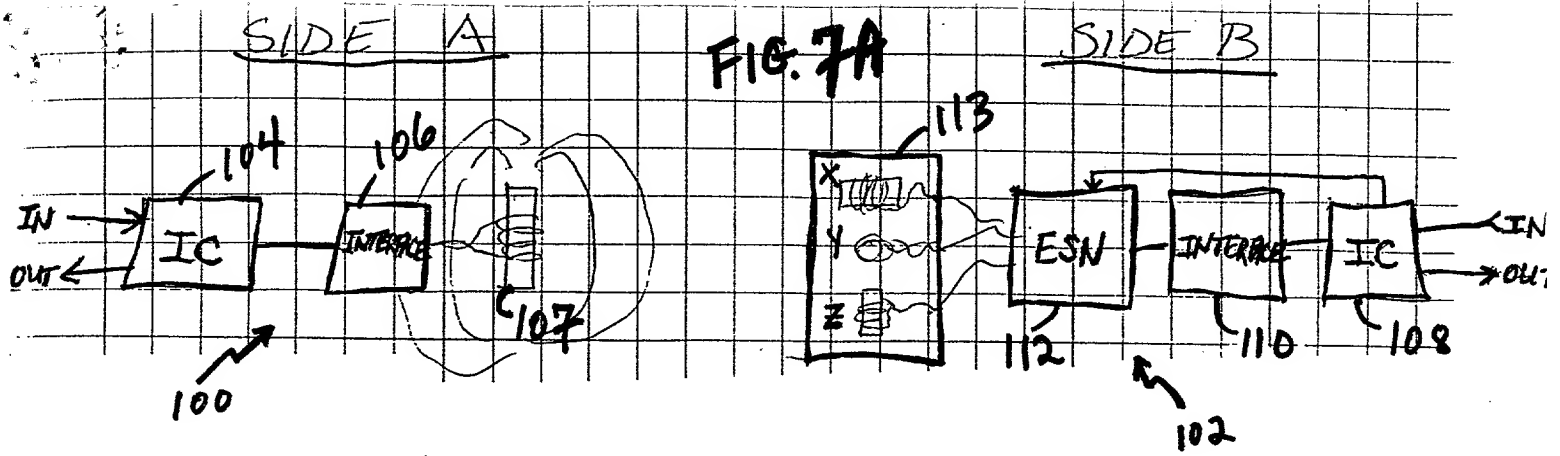


Fig. 6



**PATENT**  
Atty. Docket No. AUR-002  
(5441/3)

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**COMBINED DECLARATION AND POWER OF ATTORNEY  
FOR PATENT APPLICATION**

(Original, Design, National Stage of PCT, Supplemental, Divisional, Continuation or CIP)

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As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

TIME-MULTIPLEXED SHORT-RANGE MAGNETIC COMMUNICATIONS

the specification of which (check one):

- ☒ is attached hereto.
- ☐ was filed on \_\_\_\_\_ as Application Serial No. 0\_\_\_\_\_/\_\_\_\_ or
- ☐ was described and claimed in PCT International Application No. \_\_\_\_\_ filed on \_\_\_\_\_ and as amended under PCT Article 19 on \_\_\_\_\_ (if any).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to herein.

I acknowledge the continuing duty to disclose information which is material to the examination of this application in accordance with 37 C.F.R. §1.56.

**PRIORITY CLAIM**

- ☐ A. I hereby claim benefit under 35 U.S.C. 119(e) of United States Provisional Application No. \_\_\_\_\_, filed on \_\_\_\_\_.
- ☐ B. I hereby claim foreign priority benefits under 35 U.S.C. §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and I have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.



- ☐ no such applications have been filed.
- ☐ such applications have been filed as follows:

**EARLIEST FOREIGN APPLICATION(S), IF ANY FILED WITHIN  
12 MONTHS (6 MONTHS FOR DESIGN) PRIOR TO  
THIS U.S. APPLICATION**

Country	Application Number	Date of Filing (mo., day, year)	Priority Claimed Under 35 USC 119
			<input type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>

- ☒ C. I hereby claim the benefit under 35 U.S.C. §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose material information as defined in 37 C.F.R. §1.56 which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application.

**PRIOR U.S. NON-PROVISIONAL APPLICATIONS OR PCT INTERNATIONAL  
APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 USC §120:**

U.S. APPLICATIONS	U.S. FILING DATE	STATUS
08/444,017	May 18, 1995	Pending
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, aband.)
08/696,812	August 13, 1996	Pending
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, aband.)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, aband.)

**POWER OF ATTORNEY**

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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